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REPORT ON
A TEST TO DETERMINE THE FEASIBILITY OF AERIAL MAPPING AND COUNTING OF TREES KILLED BY THE DOUGLAS-FIR BEETLE

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INTRODUCTION

A recent cooperative aerial detection survey revealed that the Douglas-fir beetle killed large volumes of timber over an area of some three million acres in Oregon and Washington in 1951.1/ This survey provided information on the present boundaries of the infestation and the relative severity of damage by four broad classes "very heavy", "heavy", "moderate", and "light".

In order to facilitate salvage of the dead timber and control of the insect on specific areas, more intensive information on location and amount of damage is needed by timber owners planning salvage programs. This report describes an attempt to fulfill this need through testing the practicability of mapping the killed trees in place and making direct counts of them from the air. The results of aerial counts made by five different observers as compared with the actual ground count on nine study plots are described in the report and shown in Table 1.

The experiment was a cooperative undertaking by Weyerhaeuser Timber Company, the Oregon State Board of Forestry, the Pacific Northwest Forest and Range Experiment Station and the U. S. Bureau of Entomology and Plant Quarantine.

METHODS AND PROCEDURE

The area used for the experiment is in the upper Calapooya Creek drainage east of Sutherlin in southwestern Oregon on land owned by Weyerhaeuser Timber Company. Nine study plots, ranging in size from 60 to 200 acres (see Table 1) and totaling 1130 acres, were laid out in this area from the air on April 18. The plots were well distributed over an area of some 30,000 acres predominantly of Douglas-fir type. Qualifications for the plots were they they (1) contain some degree of beetle-killed timber and (2) have good natural boundaries, such as roads, streams or ridges, readily discernible from the air.

During the period April 21-23 five observers, representing the cooperating agencies, were individually flown over the test area in a Cessna 170-B airplane and directed by the pilot to map in place and make counts

1/ "Report of Reconnaissance Surveys of the 1951 Douglas-fir Barkbeetle Epidemic in Oregon and Washington" by Weyerhaeuser Timber Company, Oregon State Board of Forestry, and U. S. Bureau of Entomology and Plant Quarantine. Portland, Oregon. April 28, 1952.

of all 1951-killed trees lying within the boundaries of the 9 study plots.1/ The location of the killed trees was mapped on transparent acetate overlays placed over a 5-inch to the mile topographic base map. After completion of the plots by one observer, the overlay showing his mapping and counting was removed and an unmarked one attached for the next observer. An attempt at using 1:12000-scale aerial photographs for the mapping was unsuccessful because sufficient detail for referencing the killed trees was not apparent. Each man spent an average of 6 minutes over each plot; height above the tree tops while mapping varied from about 500 to 800 feet.

There was little difficulty in dating the mortality because practically all of it was caused by beetles that attacked in 1951. Furthermore there was a minimum of difficulty with other species of trees because Douglas-fir was the predominant species. The dead Douglas-firs recorded as killed in 1951 were of two types--trees that had lost all their needles but still had all the fine branchlets intact and trees with recently faded foliage. Both types of trees were readily detected.

The 9 study plots were 100-percent ground cruised for 1951 beetle-killed trees during the period April 29 to May 9. The 3-man cruising party was furnished by the Weyerhaeuser Timber Company Research Staff and consisted of P. Lauterbach, G. Halliburton, and R. Rowe. Approximately 30 man-days were spent on the cruising. All standing dead trees that died in 1951 were tallied by 2-inch diameter classes and plotted in place on field maps. A tally of all trees windthrown since 1949 was kept on one of the plots as a matter of interest in correlating an instance of windthrow and subsequent beetle damage. Because of the urgency of completing the experiment, the very time consuming job of recording the windthrow was not done on the rest of the plots.

RESULTS

The principal results of the experiment are summarized in Table 1, which shows the size of the plots and the comparisons between the ground count of 1951-killed trees and the aerial counts made by the 5 observers on each of the 9 plots. Aerial observers A, B, C, and D were of very nearly the same accuracy, recording 80.4, 85.1, 83.6, and 80.0 percent, respectively, of the total ground count over all 9 plots. Observer E, on the other hand, averaged 95.3 percent of the ground count. However, despite the seemingly definite superiority of observer E, and analysis

1/ Observers were as follow: A. Lindsten, Oregon State Board of Forestry; C. Mayer, Experiment Station; P. Lauterbach, and R. Ehm, Weyerhaeuser Timber Co.; and K. Wright, Bureau of Entomology. Plane pilot was J. Wear of the Bureau.

of variance of the data showed no significant difference between the five observers. Confirmation of this analysis is apparent on closer inspection of the data, which reveals considerable variation in accuracy between observers from plot to plot.

From the standpoint of flying experience, observers B, D, and E had considerable experience in the air, although none of them had previously attempted to make counts of trees from a plane. Observers A and C had no flying experience other than a few commercial or military flights.

There was considerable variation between observers in accuracy of plotting the trees in place within the plot boundaries, although all observers were within reasonable accuracy. Flight experience of the observers showed up to much better advantage in this phase of the study. The plotting of individual trees and groups of trees by the experienced observers was generally accurate within 5 chains. Mapping accuracy by the inexperienced men was variable but usually was within 10 chains of the actual location.

On the one plot where a tally of the windthrow occurring since 1949 was made, a total of 156 trees, averaging more than 40 inches in diameter, was recorded over the 90-acre area. Approximately 85 percent of this mortality occurred during the winter of 1949-50, and undoubtedly was mainly responsible for the 94 trees recorded as killed by the Douglas-fir beetle on the plot in 1951. Windthrow of considerable proportions was encountered on all plots, and was much heavier in several instances than that recorded on the plot where windthrow was tallied. Insufficient data were obtained to establish a ratio between the amount of windthrown timber and the subsequent amount of beetle-killed timber.

As a supplement to the scheduled test, one experienced observer mapped in place and counted all the 1951 beetle-killed trees in the south fork of Calapooya Creek drainage, which comprises some 10,000 acres. This area was rated on the regionwide aerial reconnaissance survey as mostly heavy or very heavy, although there were some areas on the high ridges that had little or no mortality. The entire drainage was mapped and the killed trees counted in slightly over one hour of flying time, which gives an example of the short time required to map and count killed trees over considerable acreages of infested timber. Inexperienced men would no doubt require somewhat longer to do the same job.

CONCLUSIONS AND RECOMMENDATIONS

The concensus of the five observers conducting the test was that a slow-flying airplane such as the one used is a most useful tool for determining the location and approximate number of beetle-killed trees over large areas. Results of the tests showed that relatively untrained men could accurately map insect-killed trees and count their number within approximately 85 percent accuracy from the air. It was felt that foresters familiar with their ownerships from the air could do an even more accurate job, particularly in locating the damage. By assigning the appropriate average volume to each killed tree, which will obviously vary from stand to stand, a valid estimate of loss for any area can be rapidly secured.

Following are some observations and recommendations that may be of value to forest managers undertaking aerial insect mortality evaluations on their holdings:

1. A slow-flying plane of the Cessna 170 or 170-B type, which has good forward and lateral visibility, is indispensible for accurately mapping and counting beetle-killed Douglas-fir from the air.

2. Topographic maps of one inch to the mile scale or larger appear to be the best mapping base, although small scale aerial photo mosaics (preferably 1:20,000 scale) with all streams, ridges, roads and cuttings highlighted on them should also be satisfactory.

3. All available detail such as cutting boundaries, roads, etc. should also be added to the topographic maps.

4. The area to be covered should be broken up into naturally defined mapping units or blocks of approximately 300 acres or less, depending on the terrain and degree of insect damage.

5. Maps should be attached to Masonite or metal boards, approximately 15 X 17 inches in size, for easy manipulation in the plane. Cutting the base maps to fit these boards, on a mapping-unit basis, will be necessary for areas of large ownership but causes no special difficulty.

6. Speed of the plane while mapping and counting the killed trees should be minimized as much as safety precautions will permit. It has been found that air speeds in excess of 80 miles per hour are generally too fast for accurate mapping.

7. Height above the trees for accurate mapping and counting should be from about 500 to 800 feet.

8. Although there is variation in preference between observers, it is suggested that in areas of heavy mortality all the groups of dead trees within a mapping unit be mapped in place first and then counted on a second flight.

9. A ground check of a number of groups mapped from the air should be made by each observer to obtain a conversion factor for correction of the aerial counts.

10. Beginning about mid-summer of 1952 trees killed by the current brood of beetles will begin to appear. It will be desirable to differentiate between these trees and the trees that were killed in 1951 but did not fade until the spring of 1952. Techniques for this phase of the aerial survey have not yet been perfected.

TABLE 1. COMPARISON OF AERIAL AND GROUND COUNTS OF TREES KILLED IN 1951 BY THE DOUGLAS-FIR BEETLE ON 9 STUDY PLOTS IN DOUGLAS COUNTY, OREGON

Plot No.	Plot Size (Acres)	Ground Cruise Tally (No. Trees)	AERIAL COUNTS AND ACCURACY OF 5 OBSERVERS									
			Observer A		Observer B		Observer C		Observer D		Observer E	
			No. Trees	% Accuracy	No. Trees	% Accuracy	No. Trees	% Accuracy	No. Trees	% Accuracy	No. Trees	% Accuracy
1	155	76	61	80.3	63	82.9	77	101.3	103	135.5	65	85.5
2	70	19	14	73.7	18	94.7	17	89.5	17	89.5	21	110.5
3	200	80	69	86.2	74	92.5	62	77.5	70	87.5	83	103.8
4	90	94	81	86.2	89	94.7	86	91.5	61	64.9	89	94.7
5	120	74	58	78.4	57	77.0	59	79.7	66	89.2	61	82.4
6	175	225	180	80.0	206	91.6	165	73.3	171	76.0	211	93.8
7	65	189	154	81.5	167	88.4	191	101.1	134	70.9	174	92.1
8	170	99	77	77.7	58	58.6	72	72.7	74	74.7	123	124.2
9	85	104	78	75.0	85	81.7	74	71.2	72	69.2	88	84.6
TOTALS	1130	960	772	80.4	817	85.1	803	83.6	768	80.0	915	95.3